Project number: 101006468

Project Abbreviation: PAFSE

Project Title: Partnerships for Science Education

EDUCATIONAL SCENARIOS

SCENARIO 2- ENERGY SOURCES AND PUBLIC HEALTH IMPACT

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101006468.

Content Table

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1. Specifications for the educational scenario on the theme "Energy sources and public health impact"

Context and Relevance of the Scenario for Public Health Education

Air pollution is a global problem with effects on public health. While some of the consequences of pollution are unpredictable in terms of climate change, others, such as heat-induced *stress* , chronic respiratory and cardiovascular diseases, cancers, among others, are supported by considerable facts and arguments. The energy supply system contributes on a large scale to air pollution, which annually causes more than seven million deaths worldwide, with more than four million deaths being caused by indoor (household) air pollution and more than three and a half million due to outdoor (environmental) air pollution. Given the nature of planet Earth as an energy-dependent system, the educational landscape supports physics teachers in organizing classroom debate on the energy transition to more carbon-neutral environments. The learning experience prepares young people for a heightened awareness of energy sources and the importance of renewable energy to ensure the sustainability of the planet as a viable ecosystem. The impact of the consumption of different energy sources will be discussed, with a focus on the topic of energy rationalization, and respective economic and environmental impacts. With this scenario, teachers will be raising awareness about the implications that energy choices have on problems such as air pollution, the planet and public health.

Estimated Length

- 6 lessons of 40-45 minutes (class 1 – class 6)
- 6 sessions of 40-45 minutes for the school project (session 7 – session 12)

Classroom Organization Requirements

- From lesson 1 to lesson 5, students work alone or occasionally in groups.
- From session 6 to session 12, students form groups of four/five members to develop the school research project.
- Computer use is required.
- It is recommended that, before students enter the classroom, the tables are already arranged according to the work that is going to be developed, and the computers are already turned on.
- If it is necessary, power sockets extensions should already be available to use, in order to connect all the computers to the electricity.

Prior Skills Required

- Computer use and basic knowledge of Microsoft Office software .
- Basic knowledge of English.

Scenario Glossary

Air pollution - It is the release of various pollutant gases into the atmosphere, or that can be dispersed through the air, at rates that exceed the natural capacity of the environment to dissipate, dilute or absorb them. These substances can reach concentrations in the air that cause damage to public health.

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Chemical reactions - A process in which one or more substances, the reactants , are converted into one or more different substances: the products. The substances are chemical elements or compounds. A chemical reaction rearranges the constituent atoms of reactants to create different substances as products.

Climate Change - Refers to long-term changes in temperatures and weather patterns. These changes may be natural, such as variations of the solar cycle. The consequences of climate change, today, include, but are not limited to, severe droughts, water shortages, severe fires, sea level rise, flooding, polar melt, catastrophic storms, and declining biodiversity.

Combustion - A chemical reaction between substances, usually including oxygen and usually accompanied by the production of heat and light in the form of flame.

Primary energy- It is a form of energy found in nature that has not yet undergone any conversion process of human origin. It may be energy contained in fuels available in nature (primary energy), or it may be other forms of energy. Primary energy can be renewable or non-renewable.

Principle of Energy Conservation- Principle of physics according to which the energy of bodies or particles interacting within a closed system remains constant.

Energy transfer process– Energy transfer is the process by which energy is transported from one system to another, for example, through heat transfer, work, or mass transfer. Thermal energy transfers occur in only three ways: by conduction, convection and/or radiation. When thermal energy is transferred between neighboring molecules that are in contact with each other, this heat transfer phenomenon is called conduction. Convection is the transfer of thermal energy that occurs in a fluid. Radiation is the transfer of thermal energy through space by electromagnetic radiation.

Energy Transformation Process- Energy transformation is a process that converts energy of one type (e.g., kinetic energy, gravitational potential, chemical energy) into another form of energy. Any type of energy use must involve some type of energy transformation. For example, the transformation of oil, natural gas, or hydraulic energy into electrical energy.

Indoor air pollution- Refers to chemical, biological and physical contamination of indoor air. May result in adverse health effects. In developing countries, the main source of indoor air pollution is smoke from the burning of biomass containing particulate matter (5PM), nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (Ca), formaldehyde and polycyclic aromatic hydrocarbons (PAHs).

Outdoor air pollution- It is often referred to as ambient air. Common sources of outdoor air pollution are emissions caused by the process of motor vehicle combustion, solid fuel burning and industrial activities. Other sources of pollution include smoke from wildfires, windblown dust, and biogenic emissions from vegetation (e.g. pollen).

Renewable energies- These are ways to generate energy from (theoretically) unlimited natural resources. These resources are available on an infinite time scale and are replenished at a higher rate than they are consumed. Renewables are also often referred to as “green energies” or “clean energies.” Still, this does not mean that these energies cannot be harmful to the environment and have zero impact. However, this type of energy has a low environmental impact compared to fossil fuels (Non-Renewable Energies).

Sustainable Energy Management- Combines management skills with an understanding of the responsible management of energy resources and the development of sustainable energy sources (e.g. wind, solar, biomass, water, geothermal, among others).

Pedagogical Glossary

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Active learning. A teaching and learning approach that "engages students in the process of learning through activities and/or discussion in class, rather than just listening to the expert to verify the theoretical concepts. This type of learning enhances critical thinking and often involves group work".

Brainstorming. *Brainstorming* is an instructional technique with several variations, which can be performed in groups or with the entire class. During *brainstorming* all students quickly express the ideas or concepts they consider relevant to a particular question or basic concept. The scrutiny of the ideas presented is not carried out during *brainstorming*, since the goal of the activity is the production of several divergent ideas/points of view about the same topic.

Collaborative learning. Collaborative learning is a didactic model that involves a set of pedagogical techniques, during which students cooperate and/or collaborate during the learning process, as opposed to using the traditional teaching methodology used in schools. Collaborative learning can improve learning outcomes, the level of interest and participation of learners, as well as their collaboration and communication skills.

Discussion technique. Verbal technique used for the purpose of involving a group on a given topic that will be presented/discussed. This technique consists in dividing the class into several groups where everyone participates in discussing a general theme and building a "general commitment" among everyone.

Teamwork. Deepens knowledge, research and problem-solving skills, participation/intervention, cooperation and creativity capabilities, teamwork attitudes and social skills.

Questionnaire-based learning. Research-based learning by participating learners in learning activities during which they develop various scientific research competences. Students make use of these skills to answer scientific questions posed by the students themselves or the teacher, and through the processing/analysis of experimental data collected by themselves or obtained through other sources. Some common research competences include building and using models, conducting experiments, collecting and organizing data, manipulating variables, drawing conclusions gained through data processing and communicating on scientific issues.

Project-based learning. Project-based learning is a pedagogical model of active learning. When students work as a group during project development, the situations they often face have similarities to problems with conditions close to the ones they will encounter in real life. Project-based learning includes the stages of initiation, development, and presentation.

Sources: https://www.britannica.com/Public_Health_Agency_of_Canada; EuroHealthNet; National Library of Medicine

Suggested Literature

(WHO) – Air Pollution - https://www.who.int/health-topics/air-pollution#tab=tab_1
Our World in Data – Energy Production and Consumption - https://ourworldindata.org/energy-production-consumption

Our World in Data - Energy Mix - https://ourworldindata.org/energy-mix

WMO and UNEP (World Meteorological Organization and United Nations Environment Programme), 2007.Climate Change 2007: Impacts, Adaptation and Vulnerability Working Group II, Contribution to the Intergovernmental Panel on Climate Change, Fourth Assessment Report - https://msuweb.montclair.edu/~lebelp/PSC643IntPolEcon/IPCCClimateChange2007.pdf

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Competences / Learning Objectives

Key competences
STEM/ personal, social

Knowledge

Physics concepts:
- Energy production;
- Energy transfer;
- Energy conservation;
- Primary energy and fuels;
- Renewable energy sources;
- Non-renewable energy sources.

Environmental health concepts:
- Environmental determinants of health;
- Pollution, climate change;
- Indoor air pollution, sources;
- Outdoor air pollution, sources;
- Air pollution as a risk factor for non-communicable diseases (e.g. chronic lung disease).

Concepts of epidemiology and health economics:
1. Indicators of the impact of diseases related to the loss of air quality (e.g.: deaths caused by indoor and outdoor air pollution);

Social and global health concepts:
1. Sustainable Development Goals (SDO 3 realign to 7, 11, 12, 13);
2. Growing urbanization and environmental health challenges;
3. Public policies on air pollution and energy-related issues.

Knowledge - evaluation of results:
1. Recognizes that carbon dioxide production is the main factor driving anthropogenic climate change;
2. Defines the concept of primary energy and its sources;
3. Identifies various forms of energy production and transfer;
4. Recognizes the difference between renewable and non-renewable energy sources;
5. Identifies the advantages of using renewable energy and the challenges associated with using this type of energy;
6. Identifies measures and proposes general actions to combat climate change.

Skills (Capabilities/Competencies)

In general: curiosity, cooperation, critical thinking, self-awareness, citizenship, problem solving, fact analysis and discussion, argumentation, oratory and presentation, participation in brainstorming, debate, hypothetical-deductive reasoning, inductive reasoning, problem-based learning, understanding of scientific principles and models, planning and carrying out a research-based project, critical thinking, teamwork, understanding the applications of mathematical models, risk assessment and decision-making.

Specific:
- Finds, analyzes and interprets scientific data, texts and dynamic graphical representations to establish the relationships between energy sources, air pollution and extreme weather events;
- Analyzes the overall energy production process;
- Analyzes how energy supply chains impact carbon emissions to the atmosphere;

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- Analyzes the consequences of air pollution in terms of damage to the environment, global warming and extreme weather events;
- Analyzes the public health consequences of air pollution;
- Understands the environmental and economic impacts resulting from the consumption of the most important sources of energy available on the planet;
- Obtains, evaluates and communicates facts related to energy sources and their implications in terms of indoor and outdoor air pollution;
- Obtains, evaluates and communicates facts related to the public health implications of pollution;
- Analyzes individual and community-level risks associated with emissions of gaseous pollutants into the atmosphere;
- Understands patterns of undesirable behavior in relation to domestic energy consumption;
- Understands strategies to reduce energy waste, such as more frequent use of renewable energy sources and minimizing the ecological footprint.

Competences - evaluation of results:

1. Selects appropriate concepts, indicators and facts to characterize and relate energy sources, and factors that highlight problems such as air pollution and extreme weather events;
2. Anticipates the consequences of anthropogenic activities from an individual, community and social perspective;
3. Anticipates the consequences of energy waste from an individual, community and social perspective;
4. Proposes concrete actions for the adoption of an environmentally friendly lifestyle in their routines;
5. Feels able to reduce their own ecological footprint by transitioning to a more environmentally friendly lifestyle (e.g., using public transport instead of a private car; avoiding the use of wood-burning fireplaces; cycling if possible, among others);
6. Feels able to influence the adoption of green options in relation to energy consumption by others (e.g. family, colleagues, friends);
7. Anticipates community issues and challenges in relation to SDG 7 (affordable and clean energy) and links them with other SDGs (particularly SDG 3 - health and wellbeing).

Affective Behavior/Attitude

- Adopts general attitudes towards the rationalization of energy consumption;
- Adopts actions to minimize the ecological footprint, reducing energy needs and transitioning to more sustainable energy sources;
- Builds argumentation and debates measures to reduce environmental and domestic risks, with a special focus on public policies related to SDG 7 (affordable and clean energy).

Attitudes and Behavior - Evaluation of Results:

1. Believes that civic and energy-conscious behavior is critical to minimizing air quality loss in the local community;
2. Believes that lifestyles influence extreme weather events, emissions of gaseous pollutants into the atmosphere and air quality at the community level;
3. Believes that pollution is an environmental determinant of health;
4. Disapproves patterns of energy waste in their living environment (e.g. inefficient management of basic resources such as water or electricity);
5. It is committed to addressing issues in the community related to energy supply chain management, energy efficiency and how these factors can influence the incidence of extreme weather events;
6. Considers that personal and community options in terms of energy use impact the efficiency of energy management and pollutant concentrations indoors and outdoors;
7. Is committed to communicate and actively participate in community challenges regarding energy consumption.

Learning Objectives and Outcomes

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- Uses online tools to plot charts, graphs and maps, using up-to-date data;
- Analyzes how the consequences of poorly conscious behavior can contribute to the increase in the problem of climate change;
- Obtains, evaluates, and communicates scientifically based data and information on energy sources, energy production and energy transfer;
- Gives examples of how climate change is affecting the planet and community life and well-being;
- Uses facts to propose measures and methods to efficiently rationalize energy consumption and communicate them to responsible entities within their community;
- Describes different approaches to protecting, developing and positively influencing public health;
- Uses facts to propose measures and methods to combat climate change and to communicate them to the responsible entities within his community.

Evaluation Methods

- Evaluation of result
    - Quantitative – paper questionnaire.
    - Qualitative – student project.

- Process evaluation – evaluation of the teaching-learning sequence – observation grid: reaching the target audience and extension; implementation of the scenario as planned; execution of the learning scenario as expected/organizational issues to be solved; duration of the teaching-learning sequence; number of people exposed; evaluation by level of involvement in the project – students ("Was it fun to carry out the project? Do you think it would be fun to do the project again?")/ "How do you think the project could be improved?").

Content (relevant to learning objectives and research topics)

STEM Content

- Energy conservation principle;
- Energy transfer processes (conduction, convection and radiation);
- Combustion;
- Chemical reactions;
- Sustainable energy management;
- Renewable energies;
- Primary energies conversion processes (oil, coal, among others), into useful and sustainable energy (electric energy);
- Sources of indoor and outdoor air pollution;
- Air pollution as an environmental determinant of health and associated medical conditions;
- Analysis of the occurrence of diseases attributable to ambient air pollution.

Non-STEM Content

- Lifestyles, urbanization and climate change;
- Strategies to maintain quality of life and meet basic needs with as low a level of energy consumption as possible;
- Strategies to have access to clean and affordable energy and avoid wasting energy.

Digital Learning Objects (LOs) and Digital Educational Resources (DERs)

➢ Created specifically for the PAFSE project:

- Interactive game about primary energies: respective energy consumption and rationalization **[LO1];**

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- PowerPoint explaining, for teachers and students, the sequence/explanation of the analysis of the game on primary energies **(DER1);**
- PowerPoint presentation on how to build and analyze a scientific document (**DER2**);
- Worksheets (including a version with answers for each **(DER3);**
- PowerPoint presentation on how to build a poster (**DER4**).

➢ Above mentioned resources available at the following link:

https://www.dropbox.com/sh/o8s73tgwz3g8e43/AAAtG1PaWvmO7TvIxP5JTpzVa?dl=0

➢ Game access link:

➢ Educational resources taken from other high quality sources/platforms:

About primary energy sources (images)

- https://www.sciencephoto.com/media/339586/view/a-jack-pump-used-for-oil-extraction ; (crude oil extraction) **(DER5);**
- https://www.britannica.com/science/solar-energy (Solar energy) **(DER6);**
- https://www.dw.com/en/wind-power-costs-renewable-energy/a-60046761 (Wind energy). **(DER7);**
- https://education.nationalgeographic.org/resource/natural-gas (Natural Gas) **(DER8)**;
- https://www.innovationnewsnetwork.com/hydropower-vs-wind-energy-securing-the-worlds-electricity-supply/6440/ (Hydraulic energy) **(DER9).**

On the concept of primary energy and its sources

- https://www.sciencedirect.com/topics/engineering/primary-energy-source **(DER10)**;
- https://www.eia.gov/tools/glossary **(DER11)**;
- https://www.eia.gov/energyexplained/us-energy-facts/ **(DER12)**;
- https://data.oecd.org/energy/primary-energy-supply.htm **(DER13)**.

Information on how energy consumption varies over the years

- https://yearbook.enerdata.net/total-energy/world-consumption-statistics.html **(DER14)**;
- https://yearbook.enerdata.net/ **(DER15**);
- https://ourworldindata.org/renewable-energy **(DER16)**;
- Renewables in Electricity Production | Statistics Map by Region | Enerdata **(DER17)**;
- https://afse2017.sciencesconf.org/143355/Article_su.pdf **(DER18)**.

Advantages and disadvantages of using renewable energy sources

- https://www.empower-solar.com/blog/the-advantages-disadvantages-of-switching-to-solar-energy/ **(DER19)**;
- https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy **(DER20);**
- https://www.vedantu.com/physics/non-renewable-energy **(DER21)**;
- https://greengarageblog.org/21-advantages-and-disadvantages-of-non-renewable-energy **(DER22)**;
- https://www.un.org/en/climatechange/raising-ambition/renewable-energy **(DER23)**;
- https://www.nationalgeographic.com/environment/article/fossil-fuels **(DER24)**;
- https://zbw.eu/econis-archiv/bitstream/11159/7697/1/1771636475_0.pdf **(DER25);**
- http://jocet.org/papers/092-J30008.pdf **(DER26)**;

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- https://www.researchgate.net/profile/Naeem-Abas/publication/274718268_Review_of_Fossil_Fuels_and_Future_Energy_Technologies/resources/5a1183f3aca27287ce293c6d/Review-of-Fossil-Fuels-and-Future-Energy-Technologies.pdf **(DER27);**
- https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy **(DER28)**;
- https://www.solarreviews.com/blog/hydroelectric-energy-pros-and-cons **(DER29)**;
- https://www.4gas.com/advantages-disadvantages-using-oil-energy/ **(DER30)**;
- https://eartheclipse.com/energy/advantages-disadvantages-of-coal.html **(DER31)**;
- https://group.met.com/en/media/energy-insight/advantages-and-disadvantages-of-natural-gas **(DER32)**.

Measures to reduce energy consumption

- https://portugalcleanandsafe.com/minutas/documento_tecnico_reducao_energia.pdf **(DER33)**;
- https://www.doutorfinancas.pt/energia/como-reduzir-o-consumo-de-energia-em-casa/ **(DER34)**;
- https://paylesspower.com/blog/how-to-save-energy-at-school/ **(DER35)**.

Public health impacts related to the consumption of energy sources

- https://vidasustentavel.sabado.pt/alteracoes-climaticas/alteracoes-climaticas-em-que-medida-afetam-a-nossa-saude/ **(DER36)**;
- https://climate.ec.europa.eu/climate-change/consequences-climate-change_pt **(DER37)**;
- https://www.cuf.pt/mais-saude/saude-e-poluicao-do-ar **(DER38);**
- https://journals.sagepub.com/doi/pdf/10.1260/0144598054530011 **(DER39)**;
- https://www.hindawi.com/journals/aess/2016/2707989/ **(DER40)**;
- https://aip.scitation.org/doi/pdf/10.1063/1.4993039 **(DER41);**
- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6607187/ **(DER42)**;
- https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2021EF002558 **(DER43)**.

Teaching-learning Activities (lesson plan/learning process)

Target Subject:

- Physicochemical classes (Physics);
- 7th grade (students around twelve years old);
- About 6 lessons of 40-45 minutes;
- Physics teachers integrate other colleagues into the implementation of the scenario (e.g. science teachers, ICT teachers), as the implementation of the scenario is intended to be multidisciplinary.

Topics in each lesson:

- Lesson 1: Presentation of the scenario and study and comparison of primary energy sources;
- Lesson 2: Explore the consumption of various energy sources worldwide;
- Lesson 3: Explore the differences, advantages and disadvantages of renewable and non-renewable energy sources;
- Lesson 4: Implementation of the interactive game of primary energy combinations to meet energy consumption needs;
- Lesson 5: Presentation and debate of the conclusions obtained from the activities of the previous classes;
- Lesson 6: Impacts of energy consumption on public health and preventive solutions.

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Lesson 1: Presentation of the scenario and study and comparison of primary energy sources

The main objectives to achieve in this class, from the student's perspective, are:

- Defines the concept of primary energy and its sources;
- Finds, analyzes and interprets scientific data, texts and dynamic graphical representations to establish the relationships between energy sources.

➢ Lesson 1 Summary:

In this class, the project is presented to the students and the concept of "Primary Energy" and its energy sources is explored in a simple way. The school research project will also be contextualized.

➢ Activity 1

At the beginning of the lesson, the teacher discusses with the students the objectives and planning of the next lessons, mentioning how the PAFSE project will be implemented, and also mentioning the school research project. The teacher explains the main objectives to achieve with the implementation of the scenario:

1. Students explore/study concepts related to the primary energies and sources available on the planet.
2. Students study how energy consumptions vary over the years by researching and analyzing credible data and scientific bases;
3. Students discuss and explore how we can efficiently meet the consumption needs of families, interactively, through a game, where students combine different primary energy sources to solve the problem at hand and explain the reasons why they chose one source over another;
4. Students analyze how excessive energy consumption, as well as its waste, impacts society at different levels (from a social, health, environmental and economic perspective), some of the problems being soil and water contamination, air pollution, among others;
5. Students present a series of measures and recommendations to prevent/mitigate the exploitation and excessive consumption of energy, as well as the waste of it in school and community spaces;
6. Students present the results of the school research project (facts, proposals and recommendations to the community) at the open school event.

➢ Activity 2

Before starting the activities directly related to the scenario, and because it will be important for the students in the subsequent classes, when filling out the worksheets proposed for the scenario, the teacher, after presenting the PAFSE project to the students, addresses the process of how to search for credible information when carrying out research work. For this purpose, a new PowerPoint presentation entitled "Tutorial: How to Write and Read a Scientific Document ", which the teacher uses to explain to students how a scientific document is built and analyzed. (**DER2**). To generate more interest, the first two slides have a previous question, which students answer before the slide content is displayed. The questions are "How important is it to read a scientific document?", and "How to read a scientific document?". Therefore, it should result in a debate among the students, allowing the development of their critical and argumentative thinking. Fundamentally, **DER2** is divided into two parts: the first one exposes the sequence of how to read and analyze a scientific document, as well as to focus on useful information, and the second part intends to convey to the students, step by step, how to build a scientific document from scratch. The document also presents different conventional typologies to compose the subchapter of bibliographic references (ex: *Vancouver, IEEE),*containing examples of how to mention a bibliographic reference in each of the referred typologies. The target of this activity is, on the one hand, to instruct the necessary skills for the next class to students, as they will have to research scientific information, and, on the other hand, to demonstrate how one of the most important stages of research in the STEM areas is usually carried out, via research, collection and processing of data, which will later be useful in the elaboration of the poster.

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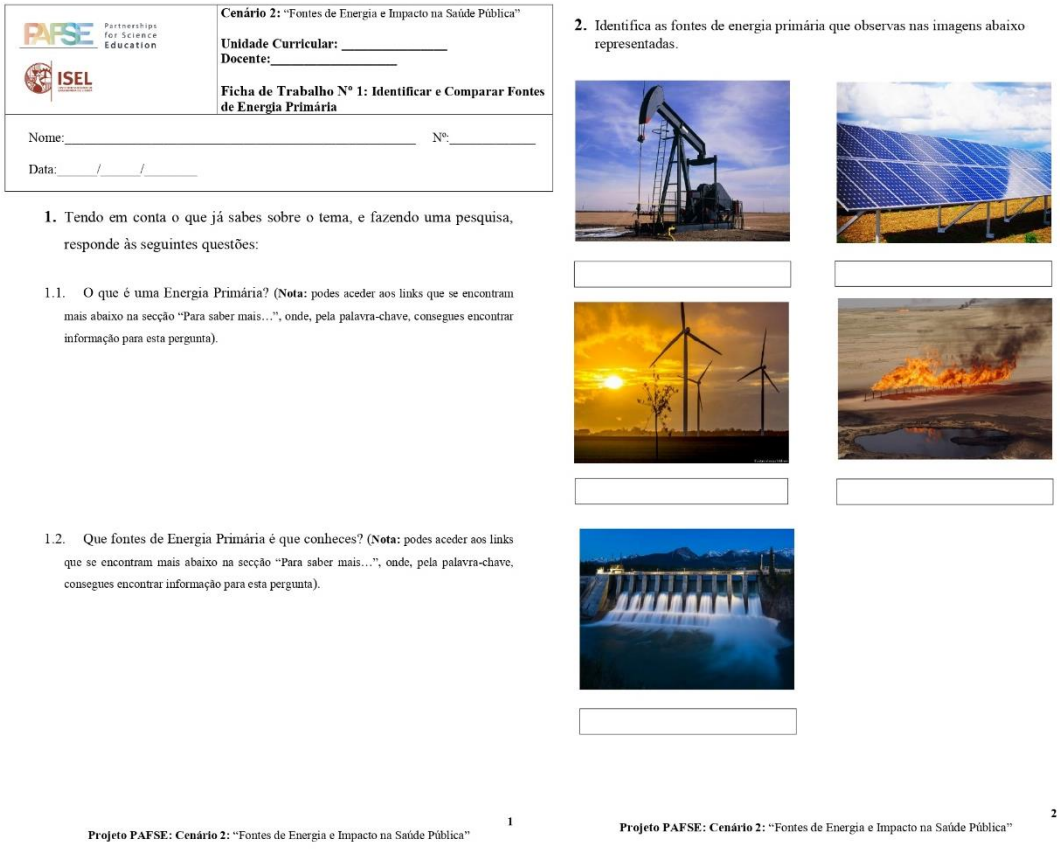
➢ Activity 3

To start the implementation of the scenario, the teacher begins by addressing the concept of "Primary Energy" and its existing sources with the class. As the activity should involve the direct participation of students, the teacher promotes a brainstorming activity with the class on the subject in question. The questions to be posed to the class are as follows:

1. "What is a Primary Energy?";
2. "Which primary energy sources do you know?".

After collecting the student's initial impressions of these questions, the teacher proposes they answer them based on scientific argumentation and proposes an investigation activity on the concepts addressed in questions 1 and 2. For this purpose, the teacher divides the class into groups of 4/5 students and distributes the proposed worksheet for this class (**DER3).** The worksheet consists of three questions. In the first one, students must carry out an autonomous research on the concept of primary energy, whereas in the second one, they must carry out the same process, this time to identify the various existing primary energy sources. In the last question they have to identify, for each image, the respective corresponding primary energy source. This worksheet is represented by the images illustrated below.



Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

Unidade Curricular: _____
Docente:_____

Ficha de Trabalho Nº 1: Identificar e Comparar Fontes de Energia Primária

Nome:_____ Nº:_____

Data:_____/_____/_____

1. Tendo em conta o que já sabes sobre o tema, e fazendo uma pesquisa, responde às seguintes questões:

1.1. O que é uma Energia Primária? (**Nota:** podes aceder aos links que se encontram mais abaixo na secção "Para saber mais…", onde, pela palavra-chave, consegues encontrar informação para esta pergunta).

1.2. Que fontes de Energia Primária é que conheces? (**Nota:** podes aceder aos links que se encontram mais abaixo na secção "Para saber mais…", onde, pela palavra-chave, consegues encontrar informação para esta pergunta).

Projeto PAFSE: Cenário 2: "Fontes de Energia e Impacto na Saúde Pública" 1

2. Identifica as fontes de energia primária que observas nas imagens abaixo representadas.

Projeto PAFSE: Cenário 2: "Fontes de Energia e Impacto na Saúde Pública" 2

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Para saber mais…

Se quiseres explorar mais sobre o tema desta aula, tens disponível na "Tabela Palavras-Chave" um conjunto de links com informações adicionais relacionados com cada palavra-chave. Para acederes a essas informações, é só carregares nos links que se encontram na secção "Referências" correspondente ao número que viste na tabela.

Tabela Palavras – Chave

Palavras-Chave	Nº de Referência
O que é Energia Primária	[1] [2] [3]
Fontes de Energia Primária	[1] [2] [3]

Referências

[1] https://www.sciencedirect.com/topics/engineering/primary-energy-source

[2] https://www.eia.gov/tools/glossary

[3] https://data.oecd.org/energy/primary-energy-supply.htm

Each worksheet in this scenario contains a version with the correct answers, which is available in the subchapter of the digital learning objects link. Regarding the worksheet, it is possible to notice, in the section "To learn more...", a table where several keywords are identified with a corresponding bibliographic reference number.
Below the table are the access links to each of the references mentioned in the table. In these links, students will be able to find the answers to questions 1 and 2, having only to select the correct keyword. Briefly, the answer that students should give to research questions 1 and 2 are as follows:

1. **Question 1:** Students should answer that primary energy is a type of energy that is found in nature and that has not undergone any conversion or treatment process. This form of energy will be subject to several processes that go through its extraction from nature, its transport, storage, and conversion into other forms of energy, such as useful energy, which can be, e.g., the electricity consumed in our homes.

2. **Question 2:** The purpose of this question is for students to identify that there are several sources of primary energy on the planet, which may be renewable, that is, they are inexhaustible resources on the planet, or they may be non-renewable, which in turn will cease to exist at some point. In renewable primary energy sources, wind, hydro or solar energy can be highlighted, and in non-renewable primary energy sources, fossil fuels such as oil, coal and natural gas can be highlighted.

In the research activity, the teacher reinforces what has already been worked on in the PowerPoint presentation from activity 2 (**DER2**), that is, the fact that students always have to check the following criteria before taking the information they obtained in the research as valid:

- The source and author of the information;
- The date it was published, because the older a document is, the greater the risks of the information being outdated;
- Additionally, the teacher encourages students to search for information in reliable databases (e.g. the World Health Organization database) and scientific articles, in order to guarantee these conditions.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101006468.

During the activity, the teacher goes around the classroom and checks if the students are having any difficulties in researching and handling information. If this happens, the teacher should reinforce the idea that students can use the "To learn more…" section to get the answers to the research questions and can structure the supporting information on the topic from the following resources:

- https://www.sciencedirect.com/topics/engineering/primary-energy-source **(DER10);**
- https://www.eia.gov/tools/glossary **(DER11);**
- https://data.oecd.org/energy/primary-energy-supply.htm **(DER13)**;

The images that will appear on the worksheet were obtained from the following resources:

- https://www.sciencephoto.com/media/339586/view/a-jack-pump-used-for-oil-extraction ; (crude oil extraction) **(DER5);**
- https://www.britannica.com/science/solar-energy (Solar energy) **(DER6);**
- https://www.dw.com/en/wind-power-costs-renewable-energy/a-60046761 (Wind energy) **(DER7);**
- https://education.nationalgeographic.org/resource/natural-gas (Natural Gas) **(DER8)**;
- https://www.innovationnewsnetwork.com/hydropower-vs-wind-energy-securing-the-worlds-electricity-supply/6440/ (Hydraulic energy) **(DER9).**

At the end of the class, the teacher reports to the students that the answers to the form should be kept for later discussion in class 5, which will be based on presentation and discussion of the answers given by the students in the various forms filled in the previous classes.

Important Final Note: In order to dynamize the activity, and for the proposed time limit for the class (40-45 minutes) to be respected, **it is imperative** that some logistic issues are already previously assured before starting the class, such as:

- It is absolutely necessary for students to have access to the internet in order to access the links provided on the form, either through computers or through their smartphones.
- The classroom should be prepared and the tables should be arranged for group work before the students come in.
- If computers will be used, a prior survey of the need for electrical power sockets should be done, since it is possible that the number of outlets in the classroom is not enough.

➢ **Learning objects to use on class 1:**

- PowerPoint presentation on how to build and analyze a scientific document. (**DER2**);
- Worksheets (including a version with answers for each) **(DER3);**
- https://www.sciencephoto.com/media/339586/view/a-jack-pump-used-for-oil-extraction (crude oil extraction) **(DER5);**
- https://www.britannica.com/science/solar-energy (Solar energy) **(DER6);**
- https://www.dw.com/en/wind-power-costs-renewable-energy/a-60046761 (Wind energy). **(DER7)**
- https://education.nationalgeographic.org/resource/natural-gas (Natural Gas) **(DER8)**;
- https://www.innovationnewsnetwork.com/hydropower-vs-wind-energy-securing-the-worlds-electricity-supply/6440/ (Hydraulic energy) **(DER9);**
- https://www.sciencedirect.com/topics/engineering/primary-energy-source **(DER10);**
- https://www.eia.gov/tools/glossary **(DER11);**
- https://data.oecd.org/energy/primary-energy-supply.htm **(DER13)**.

Lesson 2: Explore the consumption of various energy sources worldwide.

The main objectives to achieve in this class, from the student's perspective, are:

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- Identifies various forms of energy production and transfer;
- Recognizes the difference between renewable and non-renewable energy sources;
- Obtains, evaluates and communicates scientifically based data and information on energy sources, energy production, energy transfer and energy consumption.

➢ Lesson 2 Summary:

Class 2 expands student's knowledge of the paradigm of energy consumption in different regions of the world over time.

➢ Activity 1

After students have studied and understood the concept of "Primary Energy" and the various primary energy sources on the planet, it is now suggested to study how different energy sources are consumed in different regions of the world. With this, students will understand, based on scientific evidence, which energies are the most consumed in the world and in which regions they are most consumed. Through this, they will establish a fundamental relationship: the most developed countries are, by nature, the most energy consuming countries in the world, and as such, it will be demonstrated that energy consumption has a great impact in our daily lives. With the activities undertaken in this class, students will be made aware of all these matters of social relevance. As the class should involve the direct participation of students, the teacher promotes a brainstorming activity with the class, on the subject in question. The questions to be posed to the class are as follows:

1. "How much energy is consumed in the world annually?";
2. "What are the main sources of energy consumed in the world?";
3. "Is energy consumption the same in all countries, or are there differences? Why do you think there are such differences?".

After collecting the student's initial impressions of these questions, the teacher proposes they answer them based on scientific argumentation and proposes an investigation activity on the concepts addressed in questions 1, 2 and 3. For this purpose, the teacher divides the class into groups of 4/5 students (preferably, the same groups from class 1), and distributes the proposed worksheet for this class (**DER3).** The worksheet consists of three questions. In the first one, the students must analyze a bar graph with information regarding the energy consumed in the world in 2022, in the different world regions, and identify what the total energy consumed in 2022 was. In the second question, students analyze a pie chart and identify the main sources of energy consumed in 2022, and considering the total energy consumed in 2022 from the previous question, they calculate, through the energy percentages of the pie chart, the total amount of energy consumed, by energy source, in 2022. In the third question, students are challenged to reflect on why certain regions of the world, such as China and the USA, are also the most developed countries and the most energy-consuming in the world, while a less developed region (the example of Africa is given in the file) is also one of the regions where there is less energy consumption. This worksheet is represented by the images illustrated below.

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Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

Unidade Curricular: _____
Docente:_____

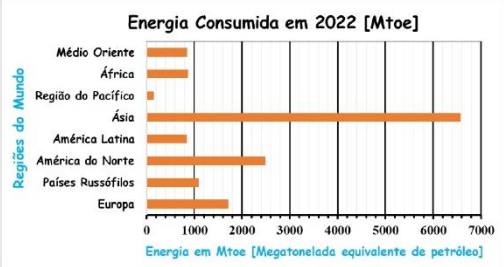
Ficha de Trabalho Nº 2: **Pesquisar, entender e debater como o consumo de energia varia em diferentes regiões do mundo**

Nome:_____ Nº:_____

Data:_____/_____/_____

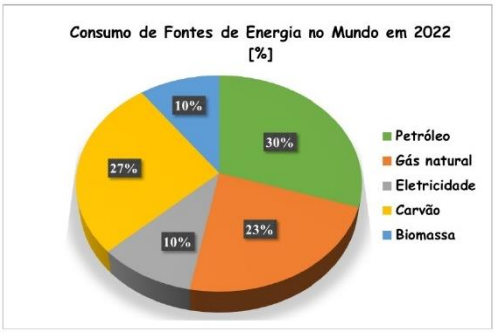
1. Tendo em conta o que já sabes sobre o tema, e fazendo uma pesquisa, responde às seguintes questões:

1.1. Através da análise do gráfico abaixo ilustrado, indica, aproximadamente qual a quantidade total de energia consumida no ano de 2022, em Mtoe.



(**Curiosidade:** 1 Mtoe ⇔ $4.1868 \cdot 10^{16}$ J (Joules))

1.2. Através da análise do gráfico circular exibido abaixo, identifica qual a principal fonte de energia consumida no ano de 2022, e de seguida, tendo em conta a resposta da alínea 1.1, indica em Mtoe, qual a quantidade de energia consumida para cada fonte de energia ilustrada no gráfico circular.



1.3. A China e os Estados Unidos são os países que atualmente apresentam maior riqueza produzida anualmente. São também os países que consomem mais energia mundialmente (3801 e 2182 Mtoe, respetivamente). África, um continente inteiro, e uma das regiões mais pobres do mundo consumiu apenas 869 Mtoe de energia em 2022. Achas que existe alguma relação causa/efeito entre o desenvolvimento dos países e o seu consumo de energia? Se sim, porque é que achas que tal acontece?

Para saber mais…

Se quiseres explorar mais sobre o tema desta aula, tens disponível na "Tabela Palavras-Chave" um conjunto de links com informações adicionais relacionados com cada palavra-chave. Para acederes a essas informações, é só carregares nos links que se encontram na secção "Referências" correspondente ao número que viste na tabela.

Tabela Palavras – Chave

Palavras-Chave	Nº de Referência
Gráfico Energia Consumida em 2022	[1]
Gráfico Circular consumo de fontes de energia	[1]
Consumo de energia por país	[1]

Referências

[1] https://yearbook.enerdata.net/total-energy/world-consumption-statistics.html

Each worksheet in this scenario contains a version with the correct answers, which is available in the subchapter of the digital learning objects link. Regarding the worksheet, it is possible to notice, in the section "To learn more...", a table where several keywords are identified with a corresponding bibliographic reference number.

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Below the table are the access links to each of the references mentioned in the table. In these links, students will be able to find the answers to questions 1, 2 and 3, having only to select the correct keyword. Briefly, the answer that students should give to research questions 1, 2 and 3 are as follows:

1. **Question 1:** The information in this graph states that in Europe about 1713 Mtoe were consumed, in Russophile countries (Russia and Russia sympathizers) 1092 Mtoe, in North America about 2483 Mtoe, in Latin America 840 Mtoe, in Asia 6580 Mtoe, in the Pacific region 156 Mtoe, in Africa 869 Mtoe and in the Middle East about 852 Mtoe, which makes a total amount of energy consumed worldwide in 2022 of approximately 14585 Mtoe $\Leftrightarrow 61 \cdot 10^{19}$ J (Joules)).

2. **Question 2:** From the analysis of the pie chart, it is possible to verify that the most consumed energy source in the world was oil with about 30%. Considering the total amount of energy consumed worldwide [14585 Mtoe] identified in question 1, converting the percentages of the pie chart we obtain that in 2022, about 4375.5 Mtoe of oil, 3937.95 Mtoe of coal, 1458.5 Mtoe of electricity, 1458.5 Mtoe of biomass and 3354.55 Mtoe of natural gas were consumed.

3. **Question 3:** In the answer to question 3, it must be concluded that there is, in fact, a relationship between the degree of development of countries and their respective energy consumption, as shown in the links referred to in the file and referenced at the beginning of the formulation of question 3, since China and the USA, the richest countries in the world, are also the most energy consuming countries, while an entire continent such as Africa is one of the regions of the world that consumes less energy. This comparison shows the importance that energy has in everyday life, since almost all our activities, from the most basic (transport, food), to the most complex (production lines, heavy industry) are somehow dependent on energy consumption, and those who are more industrialized, such as China and the USA, will naturally need to consume more energy, which is what happens.

In the research activity, the teacher reinforces what has already been worked on in the PowerPoint presentation from class 1 (**DER2**), that is, the fact that students always have to check the following criteria before taking the information they obtained in the research as valid:

- The source and author of the information;
- The date it was published, because the older a document is, the greater the risks of the information being outdated;
- Additionally, the teacher encourages students to search for information in reliable databases (e.g. the World Health Organization database) and scientific articles, in order to guarantee these conditions.

During the activity, the teacher goes around the classroom, and checks if the students are having any difficulties in researching and handling information. If this happens, the teacher should reinforce the idea that students can use the "To learn more…" section to get the answers to the research questions and can structure the supporting information on the topic from the following resources:

- https://yearbook.enerdata.net/total-energy/world-consumption-statistics.html **(DER14)**;
- https://yearbook.enerdata.net/ **(DER15)**;
- https://ourworldindata.org/renewable-energy **(DER16)**;
- Renewables in Electricity Production | Statistics Map by Region | Enerdata **(DER17)**;
- https://afse2017.sciencesconf.org/143355/Article_su.pdf **(DER18)**.

Important Final Note: In order to dynamize the activity, and for the proposed time limit for the class (40-45 minutes) to be respected, **it is imperative** that some logistic issues are already previously assured before starting the class, such as:

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- It is absolutely necessary for students to have access to the internet in order to access the links provided on the form, either through computers or through their smartphones;
- The classroom should be prepared and the tables should be arranged for group work before the students come in;
- If computers will be used, a prior survey of the need for electrical power sockets should be done, since it is possible that the number of outlets in the classroom is not enough.

➢ Learning objects to use on class 2:

- Worksheets (including a version with answers for each) **(DER3);**
- https://yearbook.enerdata.net/total-energy/world-consumption-statistics.html **(DER14)**;
- https://yearbook.enerdata.net/ **(DER15**);
- https://ourworldindata.org/renewable-energy **(DER16);**
- Renewables in Electricity Production | Statistics Map by Region | Enerdata **(DER17)**;
- https://afse2017.sciencesconf.org/143355/Article_su.pdf **(DER18)**.

Lesson 3: Explore the differences, advantages and disadvantages of renewable and non-renewable energy sources

The main objectives to achieve in this class, from the student's perspective, are:

- Recognizes the difference between renewable and non-renewable energy sources;
- Obtains, evaluates, and communicates scientifically based data and information on energy sources, energy production and energy transfer;
- Recognizes that carbon dioxide production is the main factor driving anthropogenic climate change;
- Selects appropriate concepts, indicators and facts to characterize and relate energy sources, causes of air pollution and climate change.

➢ Lesson 3 Summary:

Lesson 3 explores the main differences between renewable and non-renewable energy sources, and what possible public health impacts may result from their use.

➢ Activity 1

After students have analyzed the concept of primary energy, the main existing primary energy sources, the way they are used in different regions of the world and the impacts that energy consumption can have on our daily lives, in class 3, students are challenged to understand the main advantages and disadvantages of different renewable and non-renewable energy sources, establishing their differences. Subsequently, they are encouraged to reflect on how the consumption of each of these sources can impact the public health of the community in which they are inserted. As the class should involve the direct participation of students, the teacher promotes a brainstorming activity with the class, on the subject in question. The questions to be posed to the class are as follows:

1. “What are the main differences between renewable and non-renewable energy?”;
2. "How can the use of these fuels lead to problems such as climate change and air pollution?";
3. “Do you think renewable energy is always better than non-renewable energy? Why?".

After collecting the student’s initial impressions of these questions, the teacher proposes they answer them based on scientific argumentation and proposes an investigation activity on the concepts addressed in questions 1 and 2. For this purpose, the teacher divides the class into groups of 4/5 students and distributes the proposed worksheet for this class (**DER3).** The worksheet consists of three questions. In the first one, students must carry out an autonomous research and fill in a table with the main advantages and disadvantages they find for each primary energy source identified in the table. In the second question, students are challenged to reflect on how the use of different energy sources can lead to

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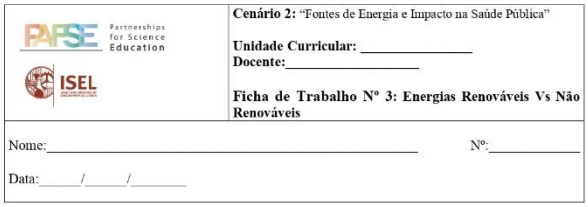
problems such as air pollution or climate change. Finally, in question 3, students are encouraged to reflect on the basis of scientific evidence on whether the use of renewable energies is always better than the use of non-renewable energies, seeking to establish the pros and cons before reaching a conclusion. This worksheet is represented by the images illustrated below.



Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

Unidade Curricular: _____
Docente:_____

Ficha de Trabalho Nº 3: Energias Renováveis Vs Não Renováveis

Nome:_____ Nº:_____

Data:_____/_____/_____

1. Tendo em conta o que já sabes sobre o tema e fazendo uma pesquisa, responde às seguintes perguntas:

1.1. Quais as principais diferenças entre uma energia renovável e uma energia não renovável? Para te ajudar a responder à pergunta, utiliza a tabela abaixo, onde podes indicar quais são as vantagens e as desvantagens de cada uma das energias apresentadas (renováveis e não renováveis). **Nota:** podes aceder aos links que se encontram mais abaixo na secção "Para saber mais…", onde, pela palavra-chave, consegues encontrar informação para esta pergunta).

	Vantagens	Desvantagens
Petróleo		
Gás Natural		
Carvão		
Energia Solar		
Energia Hídrica		
Energia Eólica		

1.2. Tendo em conta a resposta na pergunta 1.1., de que forma é que a utilização destes combustíveis pode levar a problemas como as alterações climáticas e à poluição do ar?

1.3.Tendo em conta a resposta na pergunta 1.1, dirias que as energias renováveis são sempre melhores que as energias não renováveis? Justifica a tua resposta.

1

Projeto PAFSE: Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

2

Projeto PAFSE: Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

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Para saber mais…

Se quiseres explorar mais sobre o tema desta aula, tens disponível na "Tabela Palavras-Chave" um conjunto de links com informações adicionais relacionados com cada palavra-chave. Para acederes a essas informações, é só carregares nos links que se encontram na secção "Referências" correspondente ao número que viste na tabela.

Tabela Palavras – Chave

Palavras-Chave	Nº de Referência
Vantagens e Desvantagens Energia Solar	[1]
Vantagens e Desvantagens Energia Eólica	[2]
Vantagens Energia Hídrica	[3]
Vantagens e Desvantagens Energias Não Renováveis	[4]
Vantagens Energias Renováveis	[5]
Vantagens e Desvantagens do Petróleo	[6]
Vantagens e Desvantagens do Carvão	[7]
Vantagens e Desvantagens do Gás Natural	[8]

Referências

[1] https://www.empower-solar.com/blog/the-advantages-disadvantages-of-switching-to-solar-energy/
[2] https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy
[3] https://www.solarreviews.com/blog/hydroelectric-energy-pros-and-cons
[4] https://greengarageblog.org/21-advantages-and-disadvantages-of-non-renewable-energy
[5] https://www.un.org/en/climatechange/raising-ambition/renewable-energy
[6] https://www.4gas.com/advantages-disadvantages-using-oil-energy/
[7] https://eartheclipse.com/energy/advantages-disadvantages-of-coal.html
[8] https://group.met.com/en/media/energy-insight/advantages-and-disadvantages-of-natural-gas

3

Projeto PAFSE: Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

Each worksheet in this scenario contains a version with the correct answers, which is available in the subchapter of the digital learning objects link. Regarding the worksheet, it is possible to notice, in the section "To learn more...", a table where several keywords are identified with a corresponding bibliographic reference number. Below the table are the access links to each of the references mentioned in the table. In these links, students will be able to find the answers to questions 1,2 and 3, having only to select the correct keyword. Briefly, the answer that students should give to research questions 2 and 3 are as follows:

1. **Question 2:** It should be concluded that the exploitation of some energy sources, such as fossil fuels, can lead to the worsening of problems such as climate change and air pollution due to the high emissions of C02 and GHG (greenhouse gases) when exploiting them.

2. **Question 3:** This question intends for students to reflect factually on an issue that is often taken as the utmost truth, namely, that renewable energy is always better than non-renewable energy. However, there is no doubt that the exploitation of renewable energies, from the point of view of reducing GHG and CO2 emissions to the atmosphere, presents itself as an advantage over non-renewable energies, also combining the fact they are, as the name indicates, renewable (inexhaustible). Even so, as verified in the table in question 1.1, renewable energies present some environmental problems, such as deforestation and alteration of the migration of marine species and birds, as well as economic problems, such as their high initial costs, and also some production problems, such as production inconstancy, for example, in solar and wind energy.

In the research activity, the teacher reinforces what has already been worked on in the PowerPoint presentation from class 1 (**DER2**), that is, the fact that students always have to check the following criteria before taking the information they obtained in the research as valid:

- The source and author of the information;

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- The date it was published, because the older a document is, the greater the risks of the information being outdated;
- Additionally, the teacher encourages students to search for information in reliable databases (e.g. the World Health Organization database) and scientific articles, in order to guarantee these conditions.

During the activity, the teacher goes around the classroom, and checks if the students are having any difficulties in researching and handling information. If this happens, the teacher should reinforce the idea that students can use the "To learn more…" section to get the answers to the research questions and can structure the supporting information on the topic from the following resources:

- https://www.empower-solar.com/blog/the-advantages-disadvantages-of-switching-to-solar-energy/ **(DER19)**;
- https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy **(DER20);**
- https://www.vedantu.com/physics/non-renewable-energy **(DER21)**;
- https://greengarageblog.org/21-advantages-and-disadvantages-of-non-renewable-energy **(DER22)**;
- https://www.un.org/en/climatechange/raising-ambition/renewable-energy **(DER23)**;
- https://www.nationalgeographic.com/environment/article/fossil-fuels **(DER24)**;
- https://zbw.eu/econis-archiv/bitstream/11159/7697/1/1771636475_0.pdf **(DER25)**;
- http://jocet.org/papers/092-J30008.pdf **(DER26)**;
  https://www.researchgate.net/profile/NaeemAbas/publication/274718268_Review_of_Fossil_Fuels_and_Future_Energy_Technologies/resources/5a1183f3aca27287ce293c6d/Review-of-Fossil-Fuels-and-Future-Energy-Technologies.pdf **(DER27)**;
- https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy **(DER28);**
- https://www.solarreviews.com/blog/hydroelectric-energy-pros-and-cons **(DER29)**;
- https://www.4gas.com/advantages-disadvantages-using-oil-energy/ **(DER30)**;
- https://eartheclipse.com/energy/advantages-disadvantages-of-coal.html **(DER31)**;
- https://group.met.com/en/media/energy-insight/advantages-and-disadvantages-of-natural-gas **(DER32)**;

Important Final Note: In order to dynamize the activity, and for the proposed time limit for the class (40-45 minutes) to be respected, **it is imperative** that some logistics issues are already previously assured before starting the class, such as:

- It is absolutely necessary for students to have access to the internet in order to access the links provided on the form, either through computers or through their smartphones;
- The classroom should be prepared and the tables should be arranged for group work before the students come in;
- If computers will be used, a prior survey of the need for electrical power sockets should be done, since it is possible that the number of outlets in the classroom is not enough.

➢ Learning objects to use on class 3:

- Worksheets (including a version with answers for each) **(DER3);**
- https://www.empower-solar.com/blog/the-advantages-disadvantages-of-switching-to-solar-energy/ **(DER19)**;
- https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy **(DER20);**
- https://www.vedantu.com/physics/non-renewable-energy **(DER21)**;
- https://greengarageblog.org/21-advantages-and-disadvantages-of-non-renewable-energy **(DER22)**
- https://www.un.org/en/climatechange/raising-ambition/renewable-energy **(DER23)**;
- https://www.nationalgeographic.com/environment/article/fossil-fuels **(DER24)**;
- https://zbw.eu/econis-archiv/bitstream/11159/7697/1/1771636475_0.pdf **(DER25)**;
- http://jocet.org/papers/092-J30008.pdf **(DER26)**;

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https://www.researchgate.net/profile/NaeemAbas/publication/274718268_Review_of_Fossil_Fuels_and_Future_Energy_Technologies/resources/5a1183f3aca27287ce293c6d/Review-of-Fossil-Fuels-and-Future-Energy-Technologies.pdf **(DER27);**

- https://www.energy.gov/eere/wind/advantages-and-challenges-wind-energy **(DER28);**
- https://www.solarreviews.com/blog/hydroelectric-energy-pros-and-cons **(DER29)**;
- https://www.4gas.com/advantages-disadvantages-using-oil-energy/ **(DER30)**;
- https://eartheclipse.com/energy/advantages-disadvantages-of-coal.html **(DER31)**;
- https://group.met.com/en/media/energy-insight/advantages-and-disadvantages-of-natural-gas **(DER32)**.

Lesson 4: Implementation of the interactive game of primary energy combinations to meet energy consumption needs

The main objectives to achieve in this class, from the student's perspective, are:

- Recognizes the difference between renewable and non-renewable energy sources;
- Obtains, evaluates and communicates scientifically based data and information on energy sources, energy production and energy transfer;
- Disapproves behavior such as wasting energy in their living environment;
- Adopts actions to minimize the ecological footprint, reducing energy needs and transitioning to more sustainable energy sources.

➢ Lesson 4 Summary:

In this class, students learn how to interactively combine different primary energy sources to efficiently solve a real-life problem through a game. Students will choose a primary energy source or a combination of different primary energy sources to efficiently meet the energy consumption needs of a dwelling.

➢ Activity 1

At this stage, students already have basic knowledge about primary energies, energy sources and energy consumption worldwide. They have also already established the main differences between renewable and non-renewable energy sources and how the consumption of each of these sources can impact public health problems. With this, students are challenged through the application of an interactive game **(LO1)** to combine the different primary energy sources they already know. In the game, students will have at their disposal a series of energy sources and will have to choose which ones best meet the needs of electricity consumption for each time of the day. Each selection of the best combinations of energy sources to meet energy needs will correspond to a "mission" that students must complete. In each "mission", students will have a series of indicators that will allow them to analyze whether they are making the best decision in choosing that certain energy or amount of energy. The main parameters/indicators that students will have to analyze to make their selection will be as follows:

1. Chemical Symbol;
2. SI Unit;
3. Calorific value;
4. CO2 Emission;
5. State at ambient temperature;
6. Producer countries;
7. Forms of storage;
8. Means of transport;
9. Starting time;
10. Time out of service;
11. Land occupation.

Both the teacher and the students will have at their disposal an explanatory PowerPoint on how to play the interactive game, **(DER1),** and accessing the game link, the first "mission" will be mission 0, which

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will correspond to a tutorial, in which both teachers and students will be able to explore the different features of the game. This document and the game link are available in the links in the subchapter of the digital learning objects.

Important Final Note from Lesson 4: In order to dynamize the activity, and for the proposed time limit for the class (40-45 minutes) to be respected, **it is imperative** that some logistics issues are already previously assured before starting the class, such as:

- It is of utmost importance that, **before class 4, students have already installed the game on their computers**. **The class cannot start with the installation of the game**, as this activity will consume precious class time;
- It is important that students have already read the explanatory PowerPoint (**DER1**) before class 4, for them to already be familiar with the theme of the class;
- The classroom should be prepared and the tables should be arranged for group work before the students come in;
- A prior survey of the need for electrical power sockets should be done, since it is possible that the number of outlets in the classroom is not enough.

➢ **Learning objects to use on class 4:**
- Interactive game about primary energies: respective energy consumption and rationalization. **[LO1];**
- PowerPoint explaining, for teachers and students, the sequence/explanation of the analysis of the game on primary energies **(DER1).**

➢ Lesson 5: Presentation and debate of the conclusions obtained from the activities of the previous classes

The main objectives to achieve in this class, from the student's perspective, are:

- Identifies measures and proposes general actions to better rationalize energy consumption;
- Uses facts to build argumentation about energy rationalization;
- Anticipates the consequences of anthropogenic activities, such as exploitation and excessive energy consumption from an individual, community and social perspective;
- Anticipates the benefits of energy rationalization from an individual, community and social perspective.

➢ Lesson 5 Summary:

Presentation of the resolution of the worksheets of classes 1, 2 and 3. Organization of a debate where students, based on the evidence they verified when answering the worksheets and playing the game, discuss the need to change energy consumption habits in the general population, so that they can reduce some of the problems identified in previous classes, such as climate change or air pollution, which will have direct implications for the public health of the community.

➢ Activity 1

At the beginning of the class, each group presents their worksheet's answers from classes 1, 2 and 3. A time limit is established per group, and it is mandatory that each element of each group talks at least once. While a group is presenting, the teacher tells the other groups to write down the main differences between the answers they gave and those from the group that is presenting. This contrast of ideas will be the starting point for the debate that will be held subsequently.

➢ Activity 2

In this activity, a discussion begins in the class, in which, in the first instance, the different points of view are discussed among the students, regarding the answers of the forms, and in a second moment, it

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is intended that the students discuss and produce conclusions on the topic "Reduce the consumption of energy in a house," considering energy consumption in the different rooms of the house and the behavior of its inhabitants. To address the first part of the debate, the teacher can ask the class a series of questions, which the students will have to answer, arguing with the answers of their worksheets, and what they learned from the implementation of the game. Such questions may be:

- "Which primary energy sources would you use to supply electricity to your home? And why?";
- "What consequences can the choice of your energy source have on public health?";
- "If I choose a different font than the one you selected, can I satisfy the same needs?";
- "Will the choice of renewable energy always be the best choice? Why?".

These and more questions, related to what students answered on the worksheets, can be raised by the teacher in order for students to discuss what they concluded with the worksheets answers and the implementation of the game.

In the second part of the debate, the teacher lists a series of questions, to which the students answer based on the worksheets, the scientific reports and what they learned in class 1. To address this topic of debate, the questions can be:

- "How do you think we can mitigate the public health problems caused by energy consumption?";
- "Will all energy sources have the same detrimental impact on public health?";
- "Which steps would you individually take to reduce energy waste? "What would they gain from that?";
- "And which measures would you choose to implement at school?";
- "Do you think it is important to do awareness-raising actions in the community on this topic? And why?".

In order for the debate to be conducted effectively, the teacher must discuss the rules of the debate and ensure their compliance, these rules being as follows:

- **The main focus of the debate:**

The main focus of the debate is to use scientific argumentation to discuss the different points of view on what the groups answered on the worksheets, and on general measures that students would choose to "Reduce energy consumption in a house", considering energy efficiency and the reduction of problems for public health arising from the consumption of energy sources, considering energy consumption in the different divisions of the house and the behavior of the inhabitants. Students use the knowledge acquired in the last classes and substantiate ideas/proposals to reduce energy consumption in houses.

- **The structure of the debate:**

To carry out the debate, the teacher divides the students into groups (4-5 students) and each group is given time to communicate a set of proposals on "Reducing energy consumption in a house".

- **The rules of the debate:**

Each member of each group must speak at least once, and the order and content of the intervention is previously discussed by the group members. After each group presents its measures, the other groups present their counterarguments. Then, the group which just presented is given time to counter these counterarguments. The presentation of counterarguments to the proposals presented by colleagues must be made by only one member of each group, indicated by the teams. If the other groups agree with the arguments of the group that has just presented, they must present at least one suggestion or recommendation to the measures that were mentioned by that same group..

- **Debate evaluation:**

The evaluation of the debate is at the teacher's discretion, but must involve the following criteria:

- The group that submitted the best proposals;

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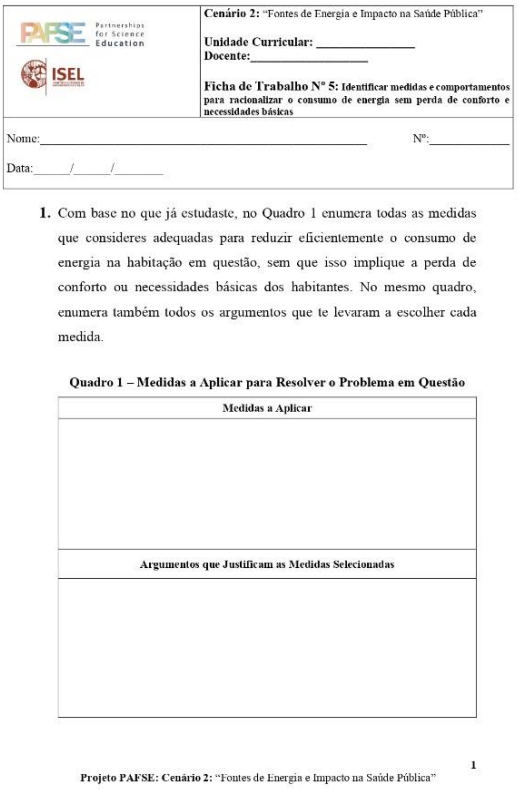
- The group that best defended their point of view;
- The group that best refuted the arguments of the other groups.

To streamline their reasoning, they will be given a worksheet **(DER3)** where students have a space to indicate the measures they consider most appropriate, and another area where they identify the arguments that justify their selections. The worksheet to be handed to the students/groups can be seen in the images below.



Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

Unidade Curricular: _____
Docente:_____

Ficha de Trabalho Nº 5: Identificar medidas e comportamentos para racionalizar o consumo de energia sem perda de conforto e necessidades básicas

Nome:_____ Nº:_____

Data:_____/_____/_____

1. Com base no que já estudaste, no Quadro 1 enumera todas as medidas que consideres adequadas para reduzir eficientemente o consumo de energia na habitação em questão, sem que isso implique a perda de conforto ou necessidades básicas dos habitantes. No mesmo quadro, enumera também todos os argumentos que te levaram a escolher cada medida.

Quadro 1 – Medidas a Aplicar para Resolver o Problema em Questão

Medidas a Aplicar
Argumentos que Justificam as Medidas Selecionadas

1

Projeto PAFSE: Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

If necessary, students can check the section "To learn more...", where they will find a table where several keywords are identified with a number of the corresponding bibliographic reference. Below the table are the access links to each of the references mentioned in the table. In these links, students may have information that assists them in completing the tables of the form of this class. The learning resources in these links are as follows:

- https://portugalcleanandsafe.com/minutas/documento_tecnico_reducao_energia.pdf **(DER33)**;
- https://www.doutorfinancas.pt/energia/como-reduzir-o-consumo-de-energia-em-casa/ **(DER34)**;
- https://paylesspower.com/blog/how-to-save-energy-at-school/ **(DER35)**.

➢ Learning objects to use on class 5:

- Worksheets (including a version with answers for each) **(DER3);**
- https://portugalcleanandsafe.com/minutas/documento_tecnico_reducao_energia.pdf **(DER33)**;
- https://www.doutorfinancas.pt/energia/como-reduzir-o-consumo-de-energia-em-casa/ **(DER34)**;
- https://paylesspower.com/blog/how-to-save-energy-at-school/ **(DER35)**.

Lesson 6: Impacts of energy consumption on public health and preventive solutions

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101006468.

The main objectives to achieve in this class, from the student's perspective, are:

- Anticipates the consequences of anthropogenic activities from an individual, community and social perspective;
- Analyzes the public health consequences of air pollution;
- Understands the environmental impacts resulting from the consumption of the energy sources available on the planet;
- Obtains, evaluates and communicates facts related to the consumption and exploitation of energy sources and their implications in terms of indoor and outdoor air pollution.

➢ Lesson 6 Summary:

In class 6, the teacher explores the knowledge developed from previous classes and directly addresses the impact on public health of the consumption of various energy sources. In this lesson, the work plan for the school research project is also defined.

➢ Activity 1

For time reasons, class 5 may not be completed in the time allowed for class, so activity 1 of class 6 will be the conclusion of class 5.

➢ Activity 2

To conclude the activities related to the scenario, the last research analysis is carried out, regarding the impacts that the consumption of the various energy sources that students have been identifying and studying over the last classes may have on the public health of the community. Students are encouraged to identify the main public health impacts resulting from problems such as air pollution and climate change, which are consequences, in part, of energy consumption. Subsequently, students are challenged to list a number of measures they would apply in their school/community to reduce the identified public health problems. This activity will subsequently serve as a "bridge" to the school research project, where students will have to select and justify, on a poster, the measures they would apply at school to reduce energy consumption, and what benefits to public health would result from the application of these measures. As the class should involve the direct participation of students, the teacher promotes a brainstorming activity with the class, on the subject in question. The questions to be posed to the class are as follows:

1. “Which public health problems do you think may arise from air pollution and climate change?”;
2. “How can we combat these public health issues? Do you think diversifying the use of energy sources can be a solution?”;
3. “Which steps would you take at school to efficiently reduce energy consumption?”.

After collecting the student’s initial impressions of these questions, the teacher proposes they answer them based on scientific argumentation and proposes an investigation activity on the concepts addressed in questions 1 and 2. For this purpose, the teacher divides the class into groups of 4/5 students and distributes the proposed worksheet for this class (**DER3).** The worksheet consists of two questions. In the first one, students have to reflect and identify, based on what they worked on in the last classes, public health problems that can arise from situations such as air pollution and climate change. In the second question they have to carry out the same process, this time to identify the various measures to combat the problems identified in the first question. Subsequently, students fill out a board with some measures they would apply in their school to efficiently reduce energy consumption. This worksheet is represented by the images illustrated below.

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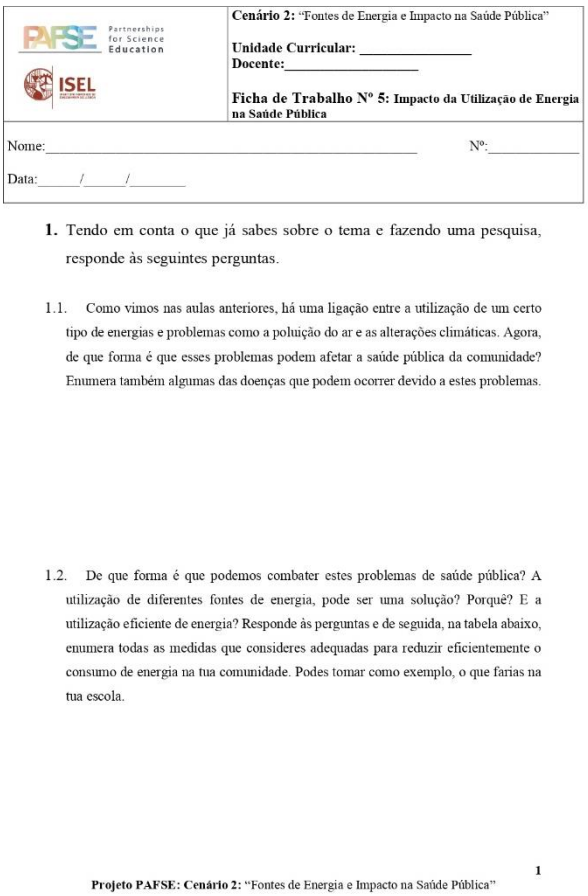


Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

Unidade Curricular: _____
Docente:_____

Ficha de Trabalho Nº 5: Impacto da Utilização de Energia na Saúde Pública

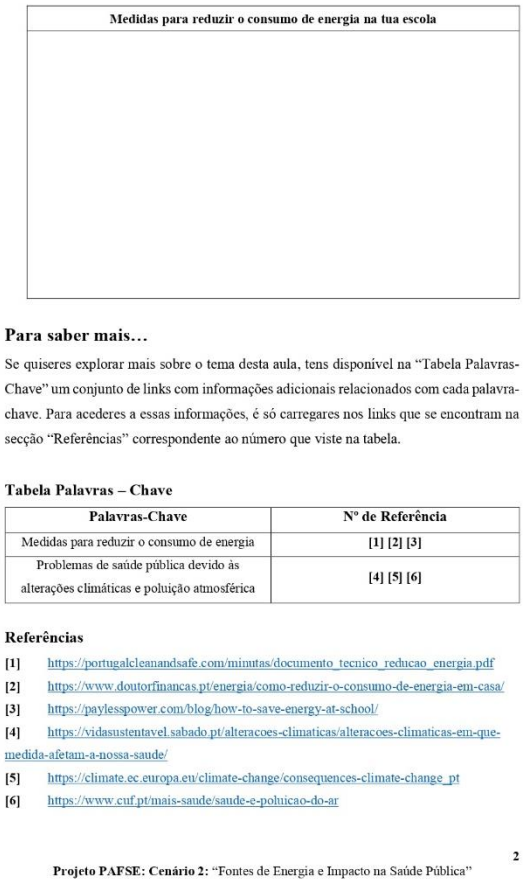
Nome:_____ Nº:_____

Data:_____/_____/_____

1. Tendo em conta o que já sabes sobre o tema e fazendo uma pesquisa, responde às seguintes perguntas.

1.1. Como vimos nas aulas anteriores, há uma ligação entre a utilização de um certo tipo de energias e problemas como a poluição do ar e as alterações climáticas. Agora, de que forma é que esses problemas podem afetar a saúde pública da comunidade? Enumera também algumas das doenças que podem ocorrer devido a estes problemas.

1.2. De que forma é que podemos combater estes problemas de saúde pública? A utilização de diferentes fontes de energia, pode ser uma solução? Porquê? E a utilização eficiente de energia? Responde às perguntas e de seguida, na tabela abaixo, enumera todas as medidas que consideres adequadas para reduzir eficientemente o consumo de energia na tua comunidade. Podes tomar como exemplo, o que farias na tua escola.



Medidas para reduzir o consumo de energia na tua escola

Para saber mais…

Se quiseres explorar mais sobre o tema desta aula, tens disponível na "Tabela Palavras-Chave" um conjunto de links com informações adicionais relacionados com cada palavra-chave. Para acederes a essas informações, é só carregares nos links que se encontram na secção "Referências" correspondente ao número que viste na tabela.

Tabela Palavras – Chave

Palavras-Chave	Nº de Referência
Medidas para reduzir o consumo de energia	[1] [2] [3]
Problemas de saúde pública devido às alterações climáticas e poluição atmosférica	[4] [5] [6]

Referências

[1] https://portugalcleanandsafe.com/minutas/documento_tecnico_reducao_energia.pdf
[2] https://www.doutorfinancas.pt/energia/como-reduzir-o-consumo-de-energia-em-casa/
[3] https://paylesspower.com/blog/how-to-save-energy-at-school/
[4] https://vidasustentavel.sabado.pt/alteracoes-climaticas/alteracoes-climaticas-em-que-medida-afetam-a-nossa-saude/
[5] https://climate.ec.europa.eu/climate-change/consequences-climate-change_pt
[6] https://www.cuf.pt/mais-saude/saude-e-poluicao-do-ar

Each worksheet in this scenario contains a version with the correct answers, which is available in the subchapter of the digital learning objects link. Regarding the worksheet, it is possible to notice, in the section "To learn more...", a table where several keywords are identified with a corresponding bibliographic reference number. Below the table are the access links to each of the references mentioned in the table. In these links, students will be able to find the answers to questions 1 and 2, having only to select the correct keyword. Briefly, the answer that students should give to research questions 1 and 2 are as follows:

1. **Question 1:** As it was found, especially when filling worksheet number 3, some energies, such as fossil fuels, can cause problems such as air pollution and the worsening of climate change. Such problems can have consequences for public health such as excessive increase in air temperature, leading to increased deaths in the summer, phenomena such as floods, fires that will later lead to problems in the community, as well as problems such as heart disease, lung disease, increased susceptibility to infections, strokes, exposure to hazardous chemicals or soil contamination.
2. **Question 2:** Individually, countering all the problems listed in 1.1 can be done through a more efficient use of the available energy resources. Choosing more sustainable renewable energy sources over non-renewable ones may be a good start. Some more energy-efficient measures can be adopted in our own house, such as using low consumption lighting systems, avoiding the continuous operation of ventilation systems, opting for the installation of heat recovery systems, purchasing energy-saving appliances, among others. Other measures of a more social nature can also be adopted, such as actions to raise awareness of the importance of efficient use of energy.

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If research is needed, the teacher reinforces what has already been worked on in the PowerPoint presentation from class 1 (**DER2**), that is, the fact that students always have to check the following criteria before taking the information they obtained in the research as valid:

- The source and author of the information;
- The date it was published, because the older a document is, the greater the risks of the information being outdated;
- Additionally, the teacher encourages students to search for information in reliable databases (e.g. the World Health Organization database) and scientific articles, in order to guarantee these conditions.

During the activity, the teacher goes around the classroom, and checks if the students are having any difficulties in researching and handling information. If this happens, the teacher should reinforce the idea that students can use the "To learn more…" section to get the answers to the research questions and can structure the supporting information on the topic from the following resources:

- https://portugalcleanandsafe.com/minutas/documento_tecnico_reducao_energia.pdf **(DER33)**;
- https://www.doutorfinancas.pt/energia/como-reduzir-o-consumo-de-energia-em-casa/ **(DER34)**;
- https://paylesspower.com/blog/how-to-save-energy-at-school/ **(DER35);**
- https://vidasustentavel.sabado.pt/alteracoes-climaticas/alteracoes-climaticas-em-que-medida-afetam-a-nossa-saude/ **(DER36)**;
- https://climate.ec.europa.eu/climate-change/consequences-climate-change_pt **(DER37)**;
- https://www.cuf.pt/mais-saude/saude-e-poluicao-do-ar **(DER38)**.

Important Final Note: In order to dynamize the activity, and for the proposed time limit for the class (40-45 minutes) to be respected, **it is imperative** that some logistics issues are already previously assured before starting the class, such as:

- It is absolutely necessary for students to have access to the internet in order to access the links provided on the form, either through computers or through their smartphones;
- The classroom should be prepared and the tables should be arranged for group work before the students come in;
- If computers will be used, a prior survey of the need for electrical power sockets should be done, since it is possible that the number of outlets in the classroom is not enough.

➢ Activity 3

In the third activity of class 6, the teacher uses **DER4,** named "School Project, how to make a poster" to present the school research project to the class. Each group is challenged to create a poster **(DER6)** that contains images, text, infographics and graphic representations, with the conclusions drawn from the analysis of the worksheets and the game. Students are encouraged to revisit the scientific articles they have consulted in the research process, to mention what primary energies are, which primary energy sources exist, how they are consumed worldwide, the main differences between non-renewable and renewable energies, and the impacts that their use can have on public health, listing the main consequences at this level. Subsequently, they must present their proposals on how to reduce energy consumption in their school, and what benefits for public health could come from the application of these measures. The best format for the presentation of the project results is discussed and the notes made by the groups throughout the implementation of the scenario (measures, justifications, filling out worksheets, notes about the game) are consulted during the project. This work developed by the students will later be presented at the open school event, as well as at the event organized by ISEL with the purpose of presenting the PAFSE project to its academic community. **DER4** is a PowerPoint that contains some examples of successful posters, as well as the main guidelines to follow to create a good poster. This document also contains an explanation of the general objectives of the school research project, as well as a tutorial that students can follow to set up a PowerPoint slide in the dimensions for

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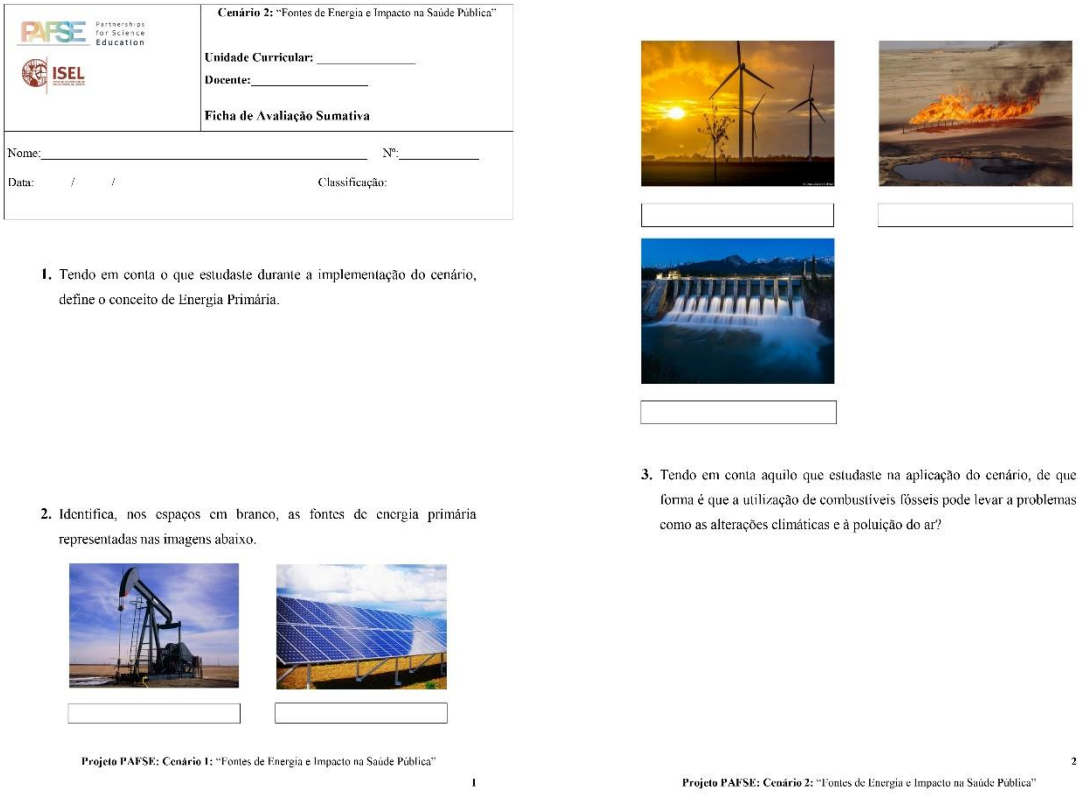
which the poster will need to be created. The project is planned to be carried out multidisciplinary, that is, several teachers will be involved in the creation of the poster. It is suggested that the computer science (ICT) teacher assists when students work with PowerPoint, the art teacher assists with poster creativity, the English teacher assists in analyzing English documents that students have to read, and the teacher responsible for teaching the scenario coordinates all project activities.

➢ Complementary activity

To conclude the project implementation, the professor has at their disposal an evaluation form **(DER3)** which sums up and reinforces the acquired knowledge throughout scenario 1. The professor can use this document as a project evaluation method, if he so understands. This worksheet, such as every other worksheet, **(DER3),** contains an answered version. Both versions are available by accessing the above-mentioned link from the learning material subchapter. An example of this worksheet can be seen below.



Cenário 2: "Fontes de Energia e Impacto na Saúde Pública"

Unidade Curricular: _____

Docente: _____

Ficha de Avaliação Sumativa

Nome: _____ Nº: _____

Data: / / Classificação:

1. Tendo em conta o que estudaste durante a implementação do cenário, define o conceito de Energia Primária.

2. Identifica, nos espaços em branco, as fontes de energia primária representadas nas imagens abaixo.

3. Tendo em conta aquilo que estudaste na aplicação do cenário, de que forma é que a utilização de combustíveis fósseis pode levar a problemas como as alterações climáticas e à poluição do ar?

Projeto PAFSE: Cenário 1: "Fontes de Energia e Impacto na Saúde Pública" 1

Projeto PAFSE: Cenário 2: "Fontes de Energia e Impacto na Saúde Pública" 2

4. Identifica 3 medidas que possam ser aplicadas, quer individualmente, quer a nível comunitário para reduzir eficientemente o consumo de energia, explicando que benefícios é que essas medidas podem trazer para a saúde pública.

➢ Learning Objects used in class 6:

- Worksheets (including a version with answers for each) (**DER3);**
- https://portugalcleanandsafe.com/minutas/documento_tecnico_reducao_energia.pdf **(DER33);**
- https://www.doutorfinancas.pt/energia/como-reduzir-o-consumo-de-energia-em-casa/ **(DER34)**;
- https://paylesspower.com/blog/how-to-save-energy-at-school/ **(DER35)**;
- https://vidasustentavel.sabado.pt/alteracoes-climaticas/alteracoes-climaticas-em-que-medida-afetam-a-nossa-saude/ **(DER36);**

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- https://climate.ec.europa.eu/climate-change/consequences-climate-change_pt **(DER37)**;
- https://www.cuf.pt/mais-saude/saude-e-poluicao-do-ar **(DER38).**

Complementary learning resources and educational activities

- Invite STEM organizations;
- Discuss energy consumption within families and organizations, climate change and the impact of these problems on public health;
- Discuss energy facts with environmental NGOs, social NGOs, government, EU and the rest of the world;
- Preliminary discussion on how countries produce energy;
- Compare the primary energies available in each country;
- Compare the energy efficiency measures implemented in each country;
- Discuss the policy of Governments for energy rationalization;
- Discuss measures to reduce air pollution and extreme weather events;
- Interact with STEM professionals.

School Research Project

Topics
- Energy sources in systems and their relationship;
- Direction in which each energy is transferred;
- Renewable energies (advantages and disadvantages of their use and consequences for the sustainability of the Earth, interdisciplinary perspective);
- Difference between temperature and heat, relating them through examples;
- Measures that promote a rational use of energy;
- Consequences for the environment due to emission of pollutants resulting from combustion reactions;
- Mitigation measures and adaptation to the aforementioned problem;
- Climate change as one of the major current problems of society;
- Relationship between air pollution and climate change;
- Air pollution as an environmental determinant of health.

Management, project and research administration.

Challenge: build a poster or infographic about Energy Rationalization!

Method (summary):

Students are organized into groups; each group addresses strategies to promote energy rationalization in their school. The project challenges each group of students to create and present an infographic that summarizes: a) what they learned throughout the teaching-learning sequence; b) measures to reduce energy consumption at the school community level; c) results relevant to the environment and public health resulting from the application of such measures. Following this process, by the end of the project, students will have understood the importance of rational use of energy and its global impacts.

Development process:

Based on the knowledge acquired in previous classes, students seek to present a series of actions/measures to be adopted by the school community to rationalize energy consumption. In the development of the project, students make observations of the infrastructure of the school community and the behavior of people on the theme “energy consumption”. The teacher discusses with the students possible questions to analyze the attributes and patterns of the school in terms of energy consumption and presents possible methods to obtain the answers. The advantages and limitations of the alternatives presented are discussed. Next, a brainstorming activity is promoted where possible starting questions to

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address the topic are launched by the teacher: 1. Are there solar panels in the school? 2. Is there an ongoing strategy to save energy? 3. Is there any strategy in place to avoid wasting water? 4. Is there an ongoing strategy to create a more sustainable environment at school? 5. What are the school's energy consumption needs?
The result of the project will be a survey of the school's strengths and weaknesses in the theme and definition of proposals to be adopted by the school community. The guiding thread of the actions and recommendations is to mitigate long-term risks (e.g., escalation of the problem of climate change, increased air pollution, increased incidence of chronic respiratory diseases, diseases, among others). Proposals related to energy rationalization should be systematically related to the benefits that the changes may bring to the health and well-being of the school community.

Poster Preparation

For the final output of the scenario, it is suggested to create a poster, a scientific presentation and an infographic, which can be built on paper or with Microsoft Office PowerPoint. Each group can focus on the assembly of one of the outputs mentioned, suggesting that the scientific presentation/poster is related to the primary energy sources and the complete characterization of these energies, also referring to the main differences between the primary energy sources studied (e.g., differences between renewable and non-renewable energies). Infographics should include information on energy consumption and public health impacts, as well as measures to efficiently reduce energy consumption, with the main objective of preventing/mitigating public health problems. In this activity, the arts teacher helps students in the design and creativity of the scientific poster and infographic and the ICT teacher helps students in the creation of the scientific presentation developed, for example, in Microsoft Office PowerPoint. In addition, Portuguese and English teachers help in the review of the texts produced in both outputs (scientific presentation/poster and infographic).

Objectives of the teaching-learning process:

The students will be able to:

1. Develop critical reasoning, as they should be able to analyze, organize, debate and share information related to class 3, that is, students are asked to meet the energy consumption needs of families with various primary energy sources at their disposal;
2. Develop digital competences (e.g., find, review and use different online resources to develop scenario activities);
3. Understand the concept of "primary energy" and its importance;
4. Understand the concepts of "production, transfer, and conservation of energy" and their importance;
5. Understand the impact at different levels (e.g. economic, social, health) of exploitation and over-consumption of energy as well as of waste of energy;
6. Develops the ability to establish different types of arguments and counterarguments to make decisions about socio-scientific issues;
7. Develops the ability to debate socio-scientific issues;
8. Investigates community perceptions and knowledge about energy waste and excessive energy consumption;
9. Develops responsible citizenship and health literacy.

Teaching-learning process for school project (summary):

1. Collection of facts (data, articles, photos).
2. Evaluation of facts based on criteria and selection of relevant, credible and non-biased information.
3. Elaboration of criteria for the evaluation of arguments.
4. Development of a calendar of tasks for the open school event.
5. Creation of a PowerPoint poster/presentation related to measures to be taken to efficiently meet energy consumption needs in different environments (e.g. school, house) for presentation at the open school event.

Organization of the open school event:

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1. Each project outcome (brochure and presentation) is presented by the students in a community setting (e.g. exhibition center, municipality, garden, museum, science fair);
2. Students will communicate selected measures to promote energy rationalization in their school using science-based argumentation. Students call for everyone's action to improve community health by providing a broad understanding that preventing energy waste is everyone's responsibility, not just the Government's or the municipalities;
3. Stakeholders understand how energy waste is influenced by individual behavior and environmental factors. They also gain high-level knowledge about strategies to minimize energy poverty and how they can influence relevant environments (e.g. house, school, workplace, public space).

Data analysis and reports
Filtering data;
Define the minimum representative data collected;
Categorization of data;
Data presentation formats;
Internal presentation:
Report writing:
Develop and create communication material.

Target audience for recommendations
Social NGOs;
Policy makers;
General public;
Media;
Families;
Friends.

Public Debate and Recommendations(based on search results)

Games between schools with similar environment: compare choices;
Games between schools with different environments: understand the connecting links and the functioning of the European Energy Market;
Discussion and feedback;
Produce information to be communicated in Public Debate;
Make recommendations for reducing energy consumption;
Disclosure of the final report and recommendations on the school's website.

Main responsible partner: ISEL

Partnerships for Science Education

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